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EXAMINER	
SHARON, AYAL I	
ART UNIT	**PAPER NUMBER**
2123	

DATE MAILED: 06/16/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Applicati n No.	Applicant(s)	
	10/024,359	KHAN, MOHAMMED ASIF	
	Examin r	Art Unit	
	Ayal I. Sharon	2123	

-- The MAILING DATE of this communication appears on the c ver sheet with th c rrespondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02 March 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-60* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-60* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 December 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *12/21/01*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Introduction

1. Claims 1-60 of U.S. Application 10/024,359 are currently pending. Claims 59 and 60 are new. The application was originally filed on 12/21/2001.

Claim Rejections - 35 USC § 101

2. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

3. **Claims 1-60 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.** The claims, as written, are directed to the manipulation of an abstract idea - a mathematical algorithm. The claimed invention is therefore not concrete or tangible. See MPEP §2106 (A), and *In re Warmerdam*, 33 F.3d 1354, 1360, 31 USPQ2d 1754, 1759 (Fed. Cir. 1994). See also *Schrader*, 22 F.3d at 295, 30 USPQ2d at 1459.

4. An invention which is eligible for patenting under 35 U.S.C. § 101 is in the "useful arts" when it is a machine, manufacture, process or composition of matter, which produces a concrete, tangible, and useful result. The fundamental test for patent eligibility is thus to determine whether the claimed invention produces a "**useful, concr te and tangibl result.**" The test for practical application as applied by the examiner involves the determination of the following factors:

- "**Useful**" - The Supreme Court in *Diamond v. Diehr* requires that the examiner look at the claimed invention as a whole and compare any asserted utility with the claimed invention to determine whether the asserted utility is accomplished. Applying utility case law the examiner will note that:
    i. the utility need not be expressly recited in the claims, rather it may be inferred.
    ii. if the utility is not asserted in the written description, then it must be well established.
- "**Tangible**" - Applying *In re Warmerdam*, 33 F.3d 1354, 31 USPQ2d 1754 (Fed. Cir. 1994), the examiner will determine whether there is simply a mathematical construct claimed, such as a disembodied data structure and method of making it. If so, the claim involves no more than a manipulation of an abstract idea and therefore, is nonstatutory under 35 U.S.C. § 101. In *Warmerdam* the abstract idea of a data structure became capable of producing a useful result when it was fixed in a tangible medium which enabled its functionality to be realized. See MPEP §2106 (A). See also *Schrader*, 22 F.3d at 295, 30 USPQ2d at 1459.
- "**Concrete**" - Another consideration is whether the invention produces a "concrete" result. Usually, this question arises when a result cannot be assured. An appropriate rejection under 35 U.S.C. § 101 should be

accompanied by a lack of enablement rejection, because the invention cannot operate as intended without undue experimentation.

5. The Examiner respectfully submits that under current PTO practice, the claimed invention does not recite *either a useful, tangible or a concrete result.*
    a. The claimed invention is not useful because neither the specification or the claims provide a specific use for the claimed invention.
    b. The method claims are not tangible because only a mathematical construct is claimed.
    c. None of the claims are concrete because there is no identifiable output. Since there are no results, results are not assured.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7. The prior art used for these rejections is as follows:
    - Feehery, W.F. et al. "A Differentiation-Based Approach to Dynamic Simulation and Optimization with High-Index Differential-Algebraic Equations." SIAM Computational Differentiation, © 1996. pp.239-253. ("F hery").

8. The claim rejections are hereby summarized for Applicant's convenience. The detailed rejections follow.

9. **Claims 1-2, 4-24, and 26-44, and 55-58 are rejected under 35 U.S.C. 102(b) as being anticipated by Feehery.**

10. In regards to Claim 1, Feehery teaches the following limitations:

> 1. A method of simulating a system, comprising:
> establishing equations modeling the system using terms having characteristics encapsulated within the terms;
> performing symbolic processing on the established equations for simplification; and
> performing system processing on the established equations for efficient simulation,
> wherein performing system processing includes processing a first set of equations including equations modeling the system and initial condition constraints and processing a second set of equations including equations modeling the system and numeric integration equations.

For example, the abstract in *Feehery*, teaches:

> Our approach requires a hybrid symbolic and numeric strategy in which we apply computational differentiation to the high-index system, and then employ a numerical integrator to solve the resulting index-1 system.

In addition, *Feehery* teaches (see p. 240, last para. to p.241, first para. Emphasis added):

> Although this is a mathematically elegant approach, the resulting TPBVP's have proved difficult to solve numerically, especially when there are inequality path constraints on state variables or the controls appear linearly in (2). Another approach is to transform the dynamic optimization problem into a nonlinear program (NLP) and apply a standard NLP solver [Kraft1985a].
>
> The advantages of the NLP approach are that the solution of the problem can in principle be **automated** because the method works directly with the original DAE system without requiring derivation of a TPBVP, and these methods have been shown to be fairly robust for solving large problems This paper deals exclusively with the NLP approach.

11. In regards to Claim 2, Feehery teaches the following limitations:

> 2. The method of claim 1, wherein the stage of defining equations further includes:
>
> defining equations modeling the system using terms selected from one or more basic terms, composite terms, or collection terms.

(See Feehery, especially: especially: p.245. Examiner interprets that the data in the binary trees correspond to the claimed "terms".)

12. In regards to Claim 4, Feehery teaches the following limitations:

> 4. The method of claim 1, further including:
>
> defining a term group including one or more terms having related functionality;
>
> evaluating each term within the term group upon an initial request for evaluation of any of the one or more terms within the term group;
>
> storing the result of the evaluation for each of the one or more terms within the term group; and
>
> recalling the stored value of the evaluated one or more terms from the term group upon a subsequent request for evaluation of the one or more terms, without performing the evaluation stage.

(See Feehery, especially: especially: p.245. Examiner interprets that the data in the binary trees correspond to the claimed "terms", and the binary trees correspond to the claimed "term group".)

13. In regards to Claim 5, Feehery teaches the following limitations:

> 5. The method of claim 1, wherein the symbolic processing stage further includes reducing the established equations, utilizing the Pantelides algorithm, to a system of equations having a differential-algebraic system of equations index of at most one.

(See Feehery, especially: Section 2.1 "A Modified Pantelides' Algorithm")

14. In regards to Claim 6, Feehery teaches the following limitations:

> 6. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:
>
> assigning equations to variables that have non-zero partial derivatives; and

differentiating the remainder of the equations.

(See Feehery, especially: p.245. "Given this subset, the binary tree is analyzed using standard recursive algorithms to derive a set of binary trees representing the non zero partial derivatives of the function.")

15. In regards to Claim 7, Feehery teaches the following limitations:

7. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:
approximating an algebraic derivative for those equations that cannot be symbolically differentiated.

(See Feehery, especially: p.245. "The presence of common subexpressions and careful selection of the rules for differentiation [Rall1981a] can also be exploited to perform simultaneous function and gradient evaluations efficiently.")

16. In regards to Claim 8, Feehery teaches the following limitations:

8. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:
symbolically integrating equations that cannot be assigned.

(See Feehery, especially: p.245. "The presence of common subexpressions and careful selection of the rules for differentiation [Rall1981a] can also be exploited to perform simultaneous function and gradient evaluations efficiently.")

17. In regards to Claim 9, Feehery teaches the following limitations:

9. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:
differentiating equations that add output derivates and integrating equations that add output integrals.

(See Feehery, especially: p.246. "... note from equation (9) that each partial derivative represents the sum over all the paths ..."

18. In regards to Claim 10, Feehery teaches the following limitations:

10. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:
eliminating an integral as each symbolically differentiated or

> integrated equation eliminates a numeric integration, such that the integral is converted to an algebraic variable by eliminating the derivative or integral relationship.

(See Feehery, especially: p.246. "... note from equation (9) that each partial derivative represents the sum over all the paths ...")

19. In regards to Claim 11, Feehery teaches the following limitations:

> 11. The method of claim 10, wherein eliminating an integral further includes:
> assigning a preferred integration location rank to one or more integrals;
> utilizing the preferred integration location rank, assigning integrals to equations; and
> eliminating the integration of assigned or solved integral variables.

(See Feehery, especially: p.246. "In the case of a combined function and gradient evaluation, correct application of the reverse mode algorithm guarantees that the binary product corresponding to each edge in the computational graph is evaluated exactly once ...")

20. In regards to Claim 12, Feehery teaches the following limitations:

> 12. The method of claim 11, wherein assigning a preferred integration location rank further includes:
> assigning a preferred integration location to one or more integrals, the user assigned preferred integration location being given the highest available
> preferred integration location rank;
> assigning a preferred integration location rank, wherein the preferred integration location rank has a lower rank than the user defined preferred integration location rank; and
> assigning all other integration locations a default lowest rank.

(See Feehery, especially: p.246. "In the case of a combined function and gradient evaluation, correct application of the reverse mode algorithm guarantees that the binary product corresponding to each edge in the computational graph is evaluated exactly once ...")

21. In regards to Claim 13, Feehery teaches the following limitations:

> 13. The method of claim 12, wherein the assigned preferred integration location is assigned by a user.

(See Feehery, especially: p.246. "In the case of a combined function and gradient evaluation, correct application of the reverse mode algorithm guarantees that the binary product corresponding to each edge in the computational graph is evaluated exactly once ...")

22. In regards to Claim 14, Feehery teaches the following limitations:

> 14. The method of claim 12, wherein the assigned preferred integration location rank is assigned by a component developer.

(See Feehery, especially: p.246. "In the case of a combined function and gradient evaluation, correct application of the reverse mode algorithm guarantees that the binary product corresponding to each edge in the computational graph is evaluated exactly once ...")

23. In regards to Claim 15, Feehery teaches the following limitations:

> 15. The method of claim 12, wherein utilizing the preferred integration location ranks to assign integrals to equations further includes:
>
> identifying integral variables that appear linearly and nonlinearly in the integral equations; establishing a current preferred integration location rank at a default setting;
>
> assigning each integral equation an integral variable that has a preferred integration location rank of less than the current preferred integration location rank, and, if possible, appears linearly in the equation; and repeating the previous three stages after increasing the current preferred integration location rank until a maximum preferred integration location rank has been exceeded.

(See Feehery, especially: p.246. "In the case of a combined function and gradient evaluation, correct application of the reverse mode algorithm guarantees that the binary product corresponding to each edge in the computational graph is evaluated exactly once ...")

24. In regards to Claim 16, Feehery teaches the following limitations:

> 16. The method of claim 15, further including:
> solving each integral equation that is assigned an integral that appears linearly in it;
> substituting the solved value into other equations; and
> if due to substitutions, an one of the assigned variables is no

longer in the equation, assign another integral with minimum integration rank to the one of the assigned variables.

(See Feehery, especially: p.246. "In the case of a combined function and gradient evaluation, correct application of the reverse mode algorithm guarantees that the binary product corresponding to each edge in the computational graph is evaluated exactly once …")

25. In regards to Claim 17, Feehery teaches the following limitations:

> 17. The method of claim 1, wherein the stage of performing system processing includes:
> establishing an initial condition system using the first set of equations and establishing a transient system using the second set of equations.

(See Feehery, especially: p.242, "2.2 The Dummy Derivative Algorithm")

26. In regards to Claim 18, Feehery teaches the following limitations:

> 18. The method of claim 17, further including:
> defining user defined and component defined initial condition equations for the initial condition system.

(See Feehery, especially: p.242, "2.1 A Modified Pantelides' Algorithm")

27. In regards to Claim 19, Feehery teaches the following limitations:

> 19. The method of claim 1, wherein performing system processing includes:
> performing the system processing on the first set of equations and the second set of equations independently and in parallel.

(See Feehery, especially: p.242, "2.2 The Dummy Derivative Algorithm")

28. In regards to Claim 20, Feehery teaches the following limitations:

> 20. The method of claim 1, wherein system processing further includes:
> replacing alias variables;
> partitioning the equations into blocks;
> tearing the blocks;
> sorting the blocks; and compressing equation terms.

(See Feehery, especially: p.240 "The DAE in this formulation has been partitioned into an index-1 DAE *f*, and a set of additional equations *c*, although this partitioning may be non-unique.")

29. In regards to Claim 21, Feehery teaches the following limitations:

> 21. The method of claim 20, wherein tearing the equations includes:
> identifying block variables in the equations in the block in which the block variables appear linearly with constant coefficients;
> solving nonlinear integration equations for their respective integrals;
> solving the linear equations;
> determining the solvability of the nonlinear equations;
> solving the nonlinear equations utilizing iterates and block variables solved from the linear equations; and
> scanning the solved variables for identification of variables that are independent and may be removed from the block.

(See Feehery, especially: pp.239-241, "1.2 Reasons for Solving High-Index DAEs")

30. In regards to Claim 22, Feehery teaches the following limitations:

> 22. The method of claim 20, wherein block sorting further includes:
> defining and identifying the blocks as static blocks, dynamic blocks, or output blocks;
> removing the static blocks from a list of blocks; and
> removing the output blocks from the list of blocks.

(See Feehery, especially: pp.239-241, "1.2 Reasons for Solving High-Index DAEs")

31. **Claims 23-24 and 26-42 are rejected based on the same reasoning as claims 1-2, 4-12, and 15-22. Claims 23-24 and 26-42 are machine-readable medium claims that recite limitations equivalent to those recited in method claims 1-2, 4-12, and 15-22 and taught throughout Fe hery.**

32. In regards to Claim 43, Feehery teaches the following limitations:

43. A method of <u>simulating systems,</u> comprising:

<u>symbolically processing a set of equations, including:</u>

Feehery teaches the following (see p. 244, last paragraph):

"In many engineering applications, it can normally be assumed that there are on average only a small number of entries in the partial derivative vector that are not identically zero The fact that this differential must also equal zero results in a new equation that is augmented to the original system. Subsequent iterations of REDUCE-INDEX may require derivation of the differential of this new equation, etc. In addition, differentiation technology is employed to derive the Jacobian of the augmented system (which has similar sparsity) for use by an index-1 solver."

assigning a portion of the set of equations to variables that have non-zero partial derivatives;

(See Feehery, especially: p.245. "Given this subset, the binary tree is analyzed using standard recursive algorithms to derive a set of binary trees representing the non zero partial derivatives of the function.")

differentiating the remainder of the set of equations;
approximating an algebraic derivative for those equations that cannot by symbolically differentiated;
symbolically integrating equations that cannot be assigned;

(See Feehery, especially: p.246. "... note from equation (9) that each partial derivative represents the sum over all the paths ...")

differentiating equations that add output derivates and integrating equations that add output integrals; and
eliminating an integral as each symbolically differentiated or integrated equation eliminates a numeric integration, such that the integral is converted to an algebraic variable by eliminating the derivative or integral relationship, and

(See Feehery, especially: p.246. "In the case of a combined function and gradient evaluation, correct application of the reverse mode algorithm guarantees that the binary product corresponding to each edge in the computational graph is evaluated exactly once ...")

<u>generating a system for simulation using the symbolically processed set of equations.</u>

(See Feehery, especially: p.242, "2.2 The Dummy Derivative Algorithm")

33. **Claim 44 is rejected based on the same reasoning as claim 43. Claim 44 is a machine-readable medium claim that recites limitations equivalent to those recited in method claim 43 and taught throughout Feehery.**

34. In regards to Claim 55, Feehery teaches the following limitations:

> 55. A method of simulating a system, comprising:
> establishing equations modeling the system using terms having characteristics encapsulated within the terms;
> performing symbolic processing on the established equations for reducing the number of terms in the equations; and
> performing system processing on the established equations for efficient simulation, and
> wherein performing system processing includes processing a first set of equations including equations modeling the system and initial condition constraints and processing a second set of equations including equations modeling the system and numeric integration equations.

For example, the abstract in *Feehery*, teaches:

> Our approach requires a hybrid symbolic and numeric strategy in which we apply computational differentiation to the high-index system, and then employ a numerical integrator to solve the resulting index-1 system.

In addition, *Feehery* teaches (see p. 240, last para. to p.241, first para. Emphasis added):

> Although this is a mathematically elegant approach, the resulting TPBVP's have proved difficult to solve numerically, especially when there are inequality path constraints on state variables or the controls appear linearly in (2). Another approach is to transform the dynamic optimization problem into a nonlinear program (NLP) and apply a standard NLP solver [Kraft1985a].
>
> The advantages of the NLP approach are that the solution of the problem can in principle be **automat d** because the method works directly with the original DAE system without requiring derivation of a TPBVP, and these

methods have been shown to be fairly robust for solving large problems This paper deals exclusively with the NLP approach.

35. In regards to Claim 56, Feehery teaches the following limitations:

56. The method of claim 55, further including:
defining a term group including one or more terns having related functionality;
evaluating each term within the term group upon an initial request for evaluation of any of the one or more terms within the term group; and
storing the result of the evaluation fro each of the one or more terms within the term group.

(See Feehery, especially: "6. Demonstration and Numerical Results.")

36. In regards to Claim 57, Feehery teaches the following limitations:

57. The method of claim 56, further including:
recalling the stored value of the evaluated one or more terms from the term group upon a subsequent request for evaluation of the one or more terms, without performing the evaluation stage.

(See Feehery, especially: "6. Demonstration and Numerical Results.")

37. **Claim 58 is rejected based on the same reasoning as claim 55. Claim 58 is a method claim that recites limitations equivalent to those recited in method claim 55 and taught throughout Feehery.**

38. In regards to Claim 59, Feehery teaches the following limitations:

59.(New) A method of simulating a system, comprising:
establishing equations modeling the system;
performing symbolic processing on the established equations for simplification;
establishing a first set of equations including equations modeling the system and initial condition constraints;
establishing a second set of equations including equations modeling the system and numeric integration equations that constrain integrated variables; and
processing the first and second sets of equations independently and in parallel, to generate initial condition and transient solutions.

Claim 59 is rejected on the same grounds as claim 1.

39. In regards to Claim 60, Feehery teaches the following limitations:

> 60. (New) The method of claim 59, wherein establishing equations modeling the system comprises establishing component equations, connectivity equations, and boundary condition equations; and wherein each of the first and second set of equations includes component, connectivity, and boundary condition equations.

Claim 60 is rejected on the same grounds as claim 2.

Claim Rejections - 35 USC § 103

40. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

41. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

42. The prior art used for these rejections is as follows:

- Feehery, W.F. et al. "A Differentiation-Based Approach to Dynamic Simulation and Optimization with High-Index Differential-Algebraic Equations." SIAM Computational Differentiation, © 1996. pp.239-253. ("**Feehery**").
- "3.1 Associating Objects in C++". http://people.cs.vt.edu/~kafura/cs2704/intro2.html. Last Updated: July 3, 1996. Printed: 11/23/05. ("**Objects in C++**").

43. The claim rejections are hereby summarized for Applicant's convenience. The detailed rejections follow.

44. **Claims 3 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Feehery in view of Objects in C++.**

45. In regards to Claim 3, Feehery does not expressly teach the following limitations:

> 3. The method of claim 1, further including:
> extending a library of terms by defining new term classes, wherein term classes define objects having characteristics encapsulated within the objects.

The "Objects in C++" reference, on the other hand, does expressly teach those limitations (see especially pp.2-3).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Feehery with those of "Objects in C++", because it was old and well known to use an object-oriented language such as C++ in order to implement mathematical algorithms on a computer.

46. **Claim 25 is r jected bas d on the sam reasoning as claim 3. Claim 25 is a machine-readabl m dium claim that recites limitations equivalent to those**

recit d in m thod claim 3 and taught throughout F h ry and Objects in C++.

Response to Arguments

Re: Claim Objections

47. Applicant's amendment to claim 7 has overcome the Examiner's objection. The objection has been withdrawn.

Re: Claim Rejections - 35 USC § 101

48. Examiner respectfully disagrees with the Applicant's arguments (see the amendment filed 3/2/06, pp.26-29) that the claims are statutory under 35 U.S.C. § 101.

49. The fundamental test for patent eligibility is to determine whether the claimed invention produces a "**useful, concrete and tangible result.**" See State Street Bank & Trust Co. v. Signature Financial Group Inc., 149 F. 3d 1368, 47 USPQ2d 1596 (Fed. Cir. 1998) and AT&T Corp. v. Excel Communications, Inc., 172 F.3d 1352, 50 USPQ2d 1447 (Fed. Cir. 1999). In these decisions, the court found that the claimed invention as a whole must accomplish a practical application. That is, it must produce a "useful, concrete and tangible result."

50. See State Street, 149 F.3d at 1373-74, 47 USPQ2d at 1601-02 (Emphasis added) ("[T]he transformation of data, representing discrete dollar amounts, by a machine through a series of mathematical calculations into a final share price,

constitutes a practical application of a mathematical algorithm, formula, or calculation, because it produces 'a useful, concrete and tangible result' – **a final share price momentarily fixed** for recording and reporting purposes and even accepted and relied upon by regulatory authorities and in subsequent trades").

51. See also AT&T, 172 F.3d at 1358, 50 USPQ2d at 1452 (Claims drawn to a **long-distance telephone billing process** containing mathematical algorithms were held patentable subject matter because the process used the algorithm to produce a useful, concrete, tangible result without preempting other uses of the mathematical principle).

52. Examiner finds that Applicant's claims do not produce a "concrete, useful, tangible result." Independent claim 1, for example, does not recite **any** final result, much less concrete, useful, and tangible final result such as those claimed in the State Street and AT&T cases. Examiner refers the Applicant to p.20 of the PTO's "Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility."

53. The Applicant argues (see the amendment filed 3/2/06, pp.27, last paragraph) that the "Applicant's claims produce useful, non-abstract results, such as systems for simulation and equations and/or data used for simulating systems, which allow, for example, systems analysis and prediction." The Examiner assumes that the argument is directed to independent claims 43 and 44, which have been amended to recite "generating a system for simulation using the

symbolically processed set of equations." Examiner notes that not all independent claims contain these limitations.

54. Examiner respectfully disagrees with Applicant's argument. Examiner finds that the claimed result of "systems for simulation" using "equations for simulation" is an attempt to patent a mathematical algorithm, in a manner that comprises every "substantial practical application". In other words, the claims are an attempt to pre-empt all intended uses of math.

55. Examiner notes that the claims do not recite **any** real-world phenomenon that can "simulated" by the claimed equations. Nor do they recite, nor hint at, any real-world application for the results.

56. "Systems for simulation ... which allow, for example, systems analysis and prediction" is a category so broad that it can encompass any system that analyses or predicts: control systems, network routers, circuit simulators, simulators of fluid dynamics, etc. The only commonality between these different fields of invention is their underlying mathematics. Examiner's therefore finds that Applicant's claims attempt to claim every "substantial practical application" thereby precluding the use of the underlying mathematics. These claims are therefore not statutory. See Gottschalk v. Benson, 409 U.S. 63, 71-72, 175 USPQ 673, 676 (1972), and also p.23 of the Interim Guidelines.

57. Examiner is therefore maintaining the 35 U.S.C. § 101 rejections, as well as applying 35 U.S.C. § 101 rejections to newly-added claims 59-60.

Re: Claim Rejections - 35 USC § 112

58. Applicant's amendments to claims 1, 23, 55, and 58 have overcome the Examiner's 35 U.S.C. § 112 rejections. The rejections have been withdrawn.

Re: Claim Rejections - 35 USC § 102 – Proof of Dissemination

59. The Applicant has requested proof of dissemination of the *Feehery* reference (see the amendment filed 3/2/06, pp.30-31).

60. Examiner previously cited a reference titled "Publications of Paul I. Barton" on the PTO-892 form dated 12/2/05. Page 6 of this reference expressly provides a 1996 date for *Feehery*.

61. In response to Applicant's request, the following references provide additional proof of dissemination.

62. "Computational Differentiation: Techniques, Applications, and Tools, Proc. AD1996, Santa Fe, New Mexico." http://bt.pa.msu.edu/papers-cgi/display.pl?name=sfbook. Printed from the Internet on 6/9/06.

- This reference teaches, in the section titled "Preference", that "This book is a selection of papers from the Second International Workshop on Computational Differentiation held in Santa Fe, New Mexico, February 12-14, 1996, under the sponsorship of the Society for Industrial and Applied Mathematics (SIAM) and the Special Interest Group on Numerical Mathematics of the Association of Computing Machinery."
- Moreover, this reference also teaches (see p.5) that the *Feehery* article is included in the published book, starting on p.239 of the published book. In

addition, the reference cited immediately above teaches (see p.6) that the publication date of the book is 1996, and the book's ISBN number is ISBN 0-89871-385-4.

63. "U.S. Copyright Office Search for TX-4-442-865". http://www.loc.gov/cgi-bin/formprocessor/copyright/locis.pl. Printed from the Internet on 6/9/06.
    - This reference teaches that the Computational Differentiation book was published on Dec. 16, 1996.
    - This reference teaches that the Computational Differentiation book was registered with the U.S. Copyright Office on Feb. 10, 1997.
64. "Second International Workshop on Computational Differentiation. February 12-15, 1996. La Fonda Hotel. Santa Fe, New Mexico". http://bt.pa.msu.edu/cd96/program.html. Dated 1/3/96. Printed from the Internet on 6/9/06.
    - This reference confirms that the Second International Workshop on Computational Differentiation was held in Santa Fe, New Mexico, February 12-15, 1996.
    - This reference further confirms that "Session 9" was held on Feb. 13, 1996, at 7:30-9:30pm.
65. "Session 9". http://bt.pa.msu.edu/cd96/s9.html. Dated 12/28/95. Printed from the Internet on 6/9/06.
    - This reference was printed from the same internet web site as the previous reference.

- This reference further confirms (see p.3) that "Session 9" was held on Feb. 13, 1996, between 7:30-9:30pm.
- This reference confirms that the Feehery reference was publicly presented on February 13, 1996, between 7:30-9:30pm.

66. "Workshop Program". http://www-unix.mcs.anl.gov/autodiff/Santa_Fe/abstracts/. Undated. Printed from the Internet on 6/9/06.
    - This reference is a different program schedule for the Second International Workshop on Computational Differentiation held in Santa Fe, New Mexico, February 12-15, 1996.
    - This reference further confirms (see p.5) that "Session 9" was held on Feb. 13, 1996, starting at 7:30pm.
    - This reference confirms (see p.5) that the *Feehery* reference was publicly presented on February 13, 1996, between 7:30-9:30pm.
67. Examiner hopes that these references satisfy the Applicant's request for proof of dissemination.

Re: Claim Rejections - 35 USC § 102 – Merits

68. In regards to independent claims 1 and 23, Applicant argues (see amendment filed 3/2/06, pp.31-32) that *Feehery* does not teach the newly amended limitations. Examiner respectfully disagrees. Examiner refers the Applicant to the abstract in *Feehery*, which teaches:

> Our approach requires a hybrid symbolic and numeric strategy in which we apply computational differentiation to the high-index system, and then employ a numerical integrator to solve the resulting index-1 system.

In addition, *Feehery* teaches (see p. 240, last para. to p.241, first para. Emphasis added):

> Although this is a mathematically elegant approach, the resulting TPBVP's have proved difficult to solve numerically, especially when there are inequality path constraints on state variables or the controls appear linearly in (2). Another approach is to transform the dynamic optimization problem into a nonlinear program (NLP) and apply a standard NLP solver [Kraft1985a].
>
> The advantages of the NLP approach are that the solution of the problem can in principle be **automated** because the method works directly with the original DAE system without requiring derivation of a TPBVP, and these methods have been shown to be fairly robust for solving large problems This paper deals exclusively with the NLP approach.

Examiner therefore interprets *Feehery's* "automated" numerical solution as corresponding to the claimed "performing system processing for efficient simulation". Examiner finds that this reads on the newly-amended limitations of independent claims 1 and 23.

69. In regards to independent claims 43 and 44, Applicant argues (see amendment filed 3/2/06, pp.32-33) that *Feehery* does not teach "assigning a portion of the set of equations to variables that have non-zero partial derivatives," as claimed. Examiner respectfully disagrees. *Feehery* teaches the following (see p. 244, last paragraph):

> In many engineering applications, it can normally be assumed that there are on average only a small number of entries in the partial derivative vector that are not identically zero The fact that this differential must also equal zero results in a new equation that is augmented to the original system. Subsequent iterations of REDUCE-INDEX may require derivation

> of the differential of this new equation, etc. In addition, differentiation technology is employed to derive the Jacobian of the augmented system (which has similar sparsity) for use by an index-1 solver

Examiner finds that this reads on the claimed limitations. The act of "assignment" is an essential, and therefore inherent, step to performing these calculations.

70. Further in regards to independent claims 43 and 44, Applicant also argues (see amendment filed 3/2/06, p.33) that *Feehery* does not teach "eliminating an integral ... such that the integral is converted to an algebraic variable," as claimed. Examiner respectfully disagrees. Examiner again refers the Applicant to the abstract in *Feehery*, which teaches (emphasis added):

> Our approach requires a hybrid symbolic and numeric strategy in which we apply computational differentiation to the high-index system, **and then employ a numerical integrator to solve the resulting index-1 system**.

Examiner finds that this reads on the claimed limitations in claims 43 and 44.

71. In regards to claims 45-52, Applicant persuasively argues (see amendment filed 3/2/06, pp.33-34) that *Feehery* does not teach "assigning a preferred integration location rank to one or more integrals" as claimed. Examiner has withdrawn the rejection. The rejections of claims 46-52 have been withdrawn for the same reason.

72. In regards to the rejections of claims 53 and 54, the Examiner finds that upon further review, *Feehery* does not expressly teach the following claimed limitations:

> determining the solvability of the nonlinear equations;

solving nonlinear integration equations for their respective integrals;

Examiner has therefore withdrawn the rejection of claims 53 and 54 that were based on *Feehery*.

73. In regards to the rejections of claims 55-57, Applicant argues (see amendment filed 3/2/06, p.36) that the new limitations that have been amended into the claims are not taught by the prior art. These new limitations are addressed in the new rejections necessitated by the amendment.
74. In regards to the rejections of claim 58, Examiner finds Applicant's argument (see amendment filed 3/2/06, p.36) to be unpersuasive. Examiner is maintaining the rejection for the same reasons that the rejections of claim 1 are being maintained.

Re: Claim Rejections - 35 USC § 103 – Regarding the References

75. In regards to the 35 U.S.C. § 103 rejections, the Applicant repeats the arguments regarding the publication date of *Feehery* (see amendment dated 3/2/06, p.37). Examiner has already addressed this issue in this Office Action. See Examiner's response to Applicant's arguments regarding the 35 U.S.C. § 102 rejections.
76. The Applicant presents a similar argument regarding the *Objects in C++* reference (see amendment dated 3/2/06, p.37). Applicant requests "requisite proof of dissemination and availability prior to Applicant's filing date." Examiner refers the Applicant to MPEP § 2128, which expressly states (emphasis added):

> **Prior art disclosur s on the Int rnet or on an on-line databas ar considered to be publicly availabl as of the date the item was**

> **publicly post d.** If the publication does not include a publication date (or retrieval date), it cannot be relied upon as prior art under 35 U.S.C. 102(a) or (b), although it may be relied upon to provide evidence regarding the state of the art. Examiners may ask the Scientific and Technical Information Center to find the earliest date of publication. See MPEP § 901.06(a), paragraph IV. G

Examiner interprets that the dates on the references are the publication dates of the references.

Re: Claim Rejections - 35 USC § 103 – Merits of the Rejection

77. Applicant argues (see amendment dated 3/2/06, p.39) that there is no motivation to combine the *Feehery* and *Objects in C++* references. Examiner respectfully disagrees.

78. Examiner stated in the original rejection that it was old and well known to use an object-oriented language such as C++ in order to implement mathematical algorithms on a computer. The cited prior art expressly teaches this motivation as well.

79. *Feehery* teaches (see p. 240, last para. to p.241, first para. Emphasis added):

> Although this is a mathematically elegant approach, the resulting TPBVP's **have proved difficult to solve numerically**, especially when there are inequality path constraints on state variables or the controls appear linearly in (2). Another approach is to transform the dynamic optimization problem into a nonlinear program (NLP) and apply a standard NLP solver [Kraft1985a].
>
> The advantages of the NLP approach are that the solution of the problem can in principle be **automated** because the method works directly with the original DAE system without requiring derivation of a TPBVP, and these methods have been shown to be fairly robust for solving large problems This paper deals exclusively with the NLP approach.

80. *Feehery's* "automated" numerical solution is a software implementation that runs on a computer. According to the cited teaching, *Feehery's* teaching is preferable to the alternative because it is easier "to solve numerically", i.e., easier to run on a computer.

81. *Objects in C++* teaches (see "1.4 Mapping Abstraction and Separation to Classes and Objects". Emphasis added):

> **Software development centers on rendering abstractions in a form that allows them to be manipulated within a software system.** An abstraction was described as a collection of attributes and a behavior. As shown in the figure below, the attributes of an abstraction are mapped to a set of data (variables, array, lists, complex data structures, etc.) and the behavior of an abstraction is mapped to a set of methods (also known as operations, functions, actions). The rendering of abstractions in software has always been the implicit goal of programming though it may have been overshadowed by more mechanical considerations.
>
> **What object-oriented programming brings to the task of capturing abstractions in software are more sophisticated structures, namely classes and objects, for representing abstractions. These new software structures permit abstractions to be represented more easily, more directly, and more explicitly.** Learning how to use existing classes to create and manipulate objects is the first step in learning about object-oriented programming. As a user, you are able to benefit from the hard work already done by the designer and implementor of existing classes. This ability to reuse existing classes is one of the major benefits of software reuse, in general, and object-oriented programming in particular.
>
> Class
>
> **A class defines the specific structure of a given abstraction (what data it has, what methods it has, how its methods are implemented).** The class has a unique name that conveys the meaning of the abstraction that it represents. The term "class" is used to suggest that it represent all the members of a given group (or class). For example, a Salesperson class might represent all individuals in the group of "people selling cars at an automobile dealership". An object represents a specific member of this group.

82. *Objects in C++* therefore teaches that it would have been obvious to one of ordinary skill in the art at the time the invention was made to implement *Feehery's* "automated" numerical solution using "object oriented programming" and "classes" because doing so "permit[s] abstractions to be represented more easily, more directly, and more explicitly." (see *Objects in C++*: "1.4 Mapping Abstraction and Separation to Classes and Objects").

Conclusion

83. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Correspondence Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ayal I. Sharon whose telephone number is (571) 272-3714. The examiner can normally be reached on Monday through Thursday, and the first Friday of a bi-week, 8:30 am – 5:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Rodriguez can be reached at (571) 272-3753.

Any response to this office action should be faxed to (571) 273-8300, or mailed to:

USPTO
P.O. Box 1450
Alexandria, VA 22313-1450

or hand carried to:

USPTO
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Tech Center 2100 Receptionist, whose telephone number is (571) 272-2100.

Ayal I. Sharon
Art Unit 2123
June 10, 2006

PRIMARY EXAMINER
6/12/06